**Objectives**

* Use the concept of buoyancy to explain how magmas rise

**Causal Principles**

1. Gravitational energy, thermal energy, and/or chemical **energy** drive all movement and change of matter on Earth.

2. A system is in **equilibrium** when energy in the system is balanced.

1. **Temperature** is a measure of the movement of molecules. Higher temperature means molecules are moving faster.
2. When molecules move faster, the **density** of most substances decreases. Water is an anomaly because liquid water is more dense than ice.
3. **Buoyancy** causes materials to rise or fall due to the relative density of materials.

**PART 1: Background Notes**

**Class Notes**

|  |  |
| --- | --- |
| Table A. Causal Principles and Hot Air Balloon | |
| **Hot Air Balloon** | **Principle** |
| Gas flame |  |
| Differences in air inside and outside the balloon |  |
| Balloon rising |  |
| Balloon floating |  |
| Outside air heating up during the day |  |

|  |  |
| --- | --- |
| Table B. Causal Principles and Magma | |
| **Magma** | **Principle** |
| Water added to hot rocks deep underground |  |
| Differences in the cold lithosphere and the hot magma |  |
| Magma rising |  |
| Magma solidifies and stops rising |  |
| Oceanic lithosphere versus continental lithosphere |  |

**Part 2. Group Work**

In Table C, align the principles that correspond with the hot air balloon and the magma. Explain how the hot air balloon and magma are different in Table D.

|  |  |  |
| --- | --- | --- |
| Table C. Comparing Hot Air Balloon and Magma | | |
| **Hot Air Balloon** | **Magma** | **Principle** |
| Gas flame |  |  |
| Differences in air inside and outside the balloon |  |  |
| Balloon rising |  |  |
| Balloon floating |  |  |
| Outside air heating up during the day |  |  |

|  |  |  |
| --- | --- | --- |
| Table D. Differences Between Hot Air Balloon and Magma | | |
| **Hot Air Balloon** | **Difference** | **Magma** |
|  | Factors impacting density of balloon/magma |  |
|  | Factors impacting buoyancy |  |

**Group Work Questions:**

1. When magma rises through the crust, the magma cools and the crust gets hotter as heat is transferred from the magma to the crust. Explain what happens to density during this process and how it will effect a magma rising through the crust:

Magma cooling:

Crust warming:

1. Ocean crust is dense and composed mostly of basalt, while continental crust is lower in density and composed mostly of granite. Considering the density differences, would the buoyant force on a basaltic magma be greater in the ocean crust or the continental crust?

**Part 3: Homework**

If you complete the group work, you may work on the homework **on your own.** This means your answers should be generally unique from other students’ answers. **Submit your homework using ANGEL**.

When magmas rise close to the surface, gas bubbles in the magma leak out of fractures in surrounding rock.

* 1. How do the gas bubbles affect the density of the magma?
  2. If the gas leaves the magma, how would it impact the buoyancy of the magma?
  3. If all of the gas in the magma leaks out, would the magma continue to rise, or would the magma stop rising and cool in place?

During subduction, water found in minerals of the oceanic lithosphere is released into the mantle. This process causes magma to form.

1. How does the water affect the melting point of the surrounding rock?
2. Once the rock is magma, why does it rise?
3. The lithosphere is solid rock. How does the magma change the surrounding rock so that it can rise through solid rock?